SONY

Product Information Manual

SNC-RX550N SNC-RX550P
SNC-RZ50N SNC-RZ50P
SNC-CS50N SNC-CS50P

Connect Your Vision

IPELA

Introduction

*As a pioneer of IP video monitoring systems, Sony has incessantly innovated and continually enhanced its line of network cameras throughout the years. Among a wealth of products, the SNC-RX550, SNC-RZ50, and SNC-CS50[*1] – which belong to the Sony IPELA™ family – incorporate a variety of intelligent features that provide high-quality images and efficient operation over IP networks.*

These cameras incorporate a number of unique features that have been designed for surveillance applications, yet can also be useful in other types of monitoring applications. Among the many features adopted by these cameras, our customers have specifically requested more detailed information on the following:

- Selectable JPEG, MPEG-4, H.264 Compression Formats/Dual Encoding Capability
- Intelligent Motion Detection
- Intelligent Object Detection
- Spherical Privacy Zone Masking
- Image Stabilizer
- Dynamic Frame Integration
- CCDs (Super HAD CCD™/Exwave HAD™ Technology/SuperExwave™ Technology)

This manual is a comprehensive guide covering the above topics and explaining how each of the intelligent network cameras utilizes the technology, while concurrently identifying user benefits. It has been written in a manner that is easy to read and comprehend. Illustrations have been used to depict concepts that are difficult to explain in words alone. And each section is written so that it can be read independently from the rest – it is not necessary to read the document from cover to cover. This manual is targeted at product and marketing managers, account managers, resellers, system integrators, and end users who have a strong desire to understand these technologies.

We hope that by reading through this manual, you will fully understand the innovative technologies that Sony has incorporated in the SNC-RX550, SNC-RZ50, and SNC-CS50 Series of network cameras. And we hope that you find these technological benefits to be a great advantage when you think about taking your surveillance and remote monitoring solution to the next step.

SNC-RZ50

SNC-CS50

SNC-RX550 (Black and White)

[*1] In the following text, "SNC-RX550," "SNC-RZ50," and "SNC-CS50" refer to both NTSC and PAL models (i.e. SNC-RX550N/SNC-RX550P, SNC-RZ50N/SNC-RZ50P, and SNC-CS50N/SNC-CS50P).

Selectable JPEG, MPEG-4, H.264 Compression Formats

The Sony SNC-RX550/RZ50/CS50 Series of network cameras is capable of encoding images using any of the following three compression formats: JPEG, MPEG-4, and H.264. This multi-codec capability allows users to flexibly choose the appropriate compression format to match their network environment and monitoring applications. This section provides a general explanation of these three compression formats beginning with the basics of video compression.

Basics of Video Compression

Most practical video compression techniques are based on lossy compression, under which there are two basic methods of compressing video: intra-frame compression and inter-frame compression.
Intra-frame compression is a technique that compresses each video frame independently without reference to any other frame of video, while inter-frame compression makes use of data from previous and/or subsequent video frames. Note that inter-frame compression is generally used in conjunction with intra-frame compression.

With intra-frame compression, each frame of video is compressed spatially (i.e. redundant or nonessential data is removed from the image).
Inter-frame compression, however, is a technique that compresses multiple video frames by utilizing data from adjacent frames (i.e. temporal prediction). Inter-frame compression takes advantage of the characteristics of video by "capturing" only the difference between successive frames. By doing so, redundant information between two frames can be eliminated, resulting in high compression ratios.

JPEG

JPEG (standardized by ISO/IEC IS 10918-1/ITU-T T.81) is the "industry-standard" image compression format for surveillance applications and is ideal for use when high-quality still images are required. These individual still images are captured in sequence of 30 (NTSC) or 25 (PAL) frames per second to form video and is sometimes referred to as "Motion JPEG." All these images are independently compressed using intra-frame compression (Fig. 1). Because intra-frame compression is the only method used, JPEG data is larger than MPEG-4 and H.264, which employ both intra-frame and inter-frame compression techniques.

With the SNC-RX550/RZ50/CS50 Series of network cameras, the JPEG picture quality can be set to a level within the range of one to ten as shown in the table below. By presetting the picture quality level, these cameras output images with a "near-constant" data size, meaning that the data size fluctuates about a pre-defined constant value. This is useful for calculating the required storage capacity and bandwidth for streaming JPEG images over a network.

Level	Approximate Data Size [Resolution (pixels)]			Compression Ratio (approx.)
	VGA (640 x 480)	QVGA (320 x 240)	QQVGA (160 x 120)	
10	150 KB	45 KB	11.25 KB	1/6
9	90 KB	22.5 KB	5.625 KB	1/10
8	60 KB	15 KB	3.75 KB	1/15
7	45 KB	11.25 KB	2.8125 KB	1/20
6	36 KB	9 KB	2.25 KB	1/25
5	30 KB	7.5 KB	1.875 KB	1/30
4	25.7 KB	6.43 KB	1.607 KB	1/35
3	22.5 KB	5.625 KB	1.406 KB	1/40
2	18 KB	4.5 KB	1.125 KB	1/50
1	15 KB	3.75 KB	0.9375 KB	1/60

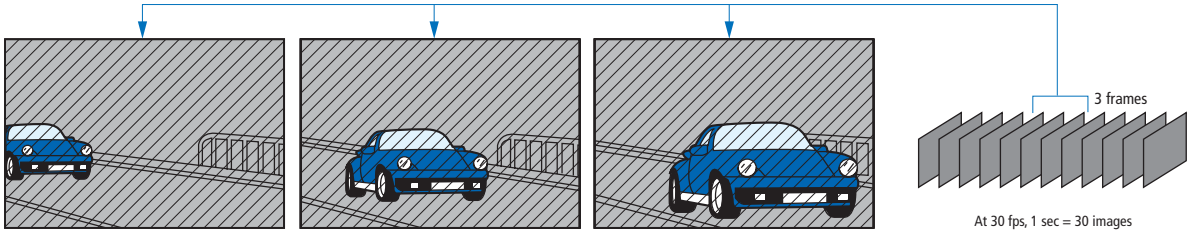

Fig. 1 "Motion JPEG" Structure

MPEG-4

Before looking at the MPEG-4 compression format adopted by these cameras, it is important to clarify the term "MPEG-4." MPEG-4 is a series of standards developed by ISO/IEC MPEG (Motion Pictures Experts Group) and has many "Parts," "Profiles," and "Levels" related to multimedia content. Among these "Parts," "Profiles," and "Levels," the SNC-RX550/RZ50/CS50 Series of network cameras employs MPEG-4 Part 2 (ISO/IEC 14496-2) Simple Profile Level 3, and MPEG-4 Part 10 (ISO/IEC 14496-10), which is also called H.264 and was jointly developed with ITU-T. In the following text, "MPEG-4" refers to MPEG-4 Part 2 Simple Profile Level 3 and "H.264" refers to MPEG-4 Part 10.

Structure of MPEG-4

Let's take a look at the structure of MPEG-4. A video "frame" in MPEG-4 is referred to as a Video Object Plane (VOP). There are two types of VOPs: an I-VOP (initial) and a P-VOP (predictive). A Group of VOPs (GOV) consists of an I-VOP and several P-VOPs. In these cameras, a GOV makes up one second[*2] of video (Fig. 2).

An I-VOP is compressed using the intra-frame compression technique and is similar to a single JPEG image. This initial "frame" of a GOV is often called an "anchor." I-VOPs are much larger in data size than P-VOPs; however, they are essential in the GOV structure, and are required when searching image data.

P-VOP data is generated by predicting the difference between the "current image" and the previously encoded I-VOP or P-VOP (reference frame). This is performed using inter-frame compression. As explained in the section on "Basics of Video Compression," this method of prediction takes advantage of the video property that two consecutive "frames" are very similar. Because P-VOP data contains information related only to the difference between two frames (i.e. VOPs) and not the image data itself, the data size of P-VOPs are greatly reduced when compared to I-VOPs.

P-VOPs and Motion Compensation

"Motion Compensation" is the key to predicting movement within an image and forming P-VOP data to efficiently compress MPEG-4 video. This section briefly introduces this technique.

As described above, P-VOP data is generated by predicting the difference between the previous VOP (reference VOP) and the current image that is input from the camera. To predict this movement, "blocks" consisting of 16 x 16 pixels, called macroblocks are first formed within the image. Next, motion vectors are calculated based on the predicted movement within each macroblock. The prediction process is such that the movement within each macroblock between the reference VOP and the current image is compared. The resultant "shift" of the comparison is represented as a motion vector.[*3]

In MPEG-4, sub-blocks consisting of 8 x 8 pixels within the 16 x 16 macroblocks can also be used to predict the current VOP (Fig. 3). The smaller the "frame" is divided, the more accurately movement can be predicted, which can result in an even higher compression ratio.

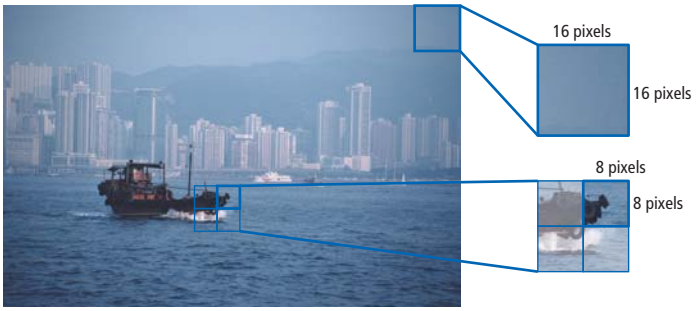

Fig. 3 MPEG-4 Motion Compensation Blocks

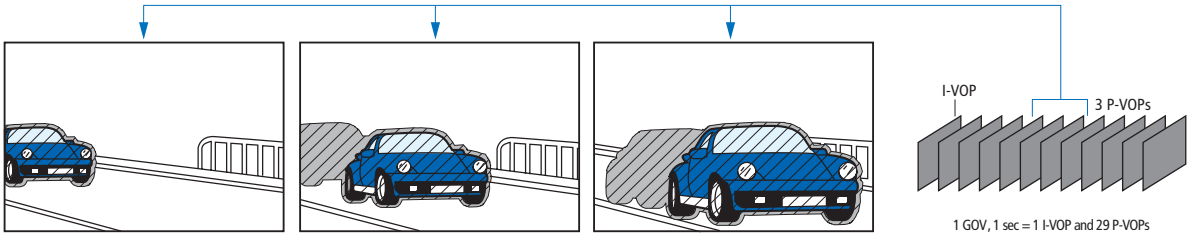

Fig. 2 MPEG-4 GOV Structure

*2 The default GOV setting of SNC-RX550/RZ50/CS50 Series of network cameras is one second. The length of a GOV can be set between one and five seconds.

*3 The actual prediction process utilizes a number of feedback loops and complicated algorithms including triggers to reset the I-VOP when there are extreme movement patterns. This method helps to accurately produce motion vectors. Further technical details are beyond the scope of this paper.

H.264

H.264 (or MPEG-4 Part 10) has been developed with the aim of providing high-quality video at a much lower bit rate than MPEG-4. A number of techniques for achieving efficient compression are incorporated in H.264. One major contributing factor is the improvement in motion prediction.

As in the case of MPEG-4, each image is divided into blocks to predict movement. However, with H.264, the block patterns can be a 16 x 16 pixel macroblock or any combination of the seven options shown in Fig. 4 (e.g. 4 x 4 sub-blocks in the upper right quadrant of the macroblock, an 8 x 8 sub-block in the upper left quadrant, and an 8 x 16 sub-block in the lower half, as shown in Fig. 5). The block pattern is variably determined depending on the amount and speed of movement within the image. If an area of the image has little movement, the algorithm utilizes large blocks (such as 16 x 16 pixels or 8 x 8 pixels) to predict the difference between the previous VOP and the current image. However, where an area of the image includes significant motion, the algorithm utilizes smaller blocks for prediction. By dynamically adapting the size of each block to the amount of motion, the prediction accuracy for each block is significantly improved. Because the predicted data is more accurate, less image data needs to be transmitted; therefore, compression efficiency is greatly improved when compared to MPEG-4.

Though motion prediction using variable block sizes increases prediction accuracy and minimizes the amount of data to be transmitted, it does require greater processing power within the codec.

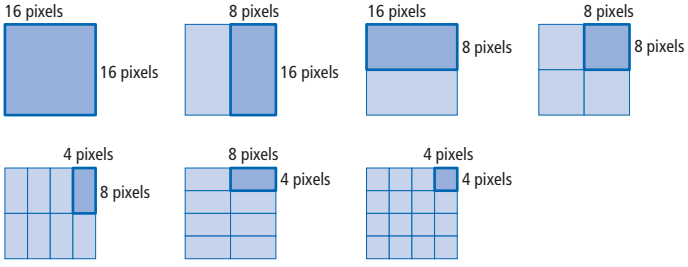

Fig. 4 H.264 Motion Compensation Blocks

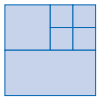

Fig. 5 H.264 Combination Block Pattern

JPEG/MPEG-4/H.264 Comparison

The difference between JPEG, MPEG-4, and H.264 compression formats has been explained in the above sections. Here, let's relate picture quality to transmission bit rate.

Fig. 6 is a graph depicting the picture quality vs. the bit rate of these three compression formats.[*4] The vertical axis (PSNR level) expresses the picture quality, and the horizontal axis expresses the transmission bit rate. PSNR (Peak Signal-to-Noise Ratio) is a metric widely used by engineers to measure the "quality" of compressed video images.

At a PSNR of 35 dB, JPEG images are transmitted at approximately 260 Kb/s, while MPEG-4 transmits at approximately 85 Kb/s and H.264 transmits at 50 Kb/s. To put this into perspective, MPEG-4 requires approximately one-third of the bandwidth used by JPEG, and H.264 requires just one-fifth.

In summary, both MPEG-4 and H.264 are ideal for image transfer over a network because they require much less network bandwidth than JPEG.

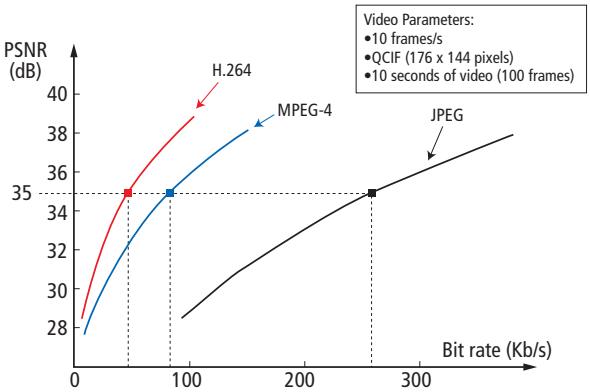

Fig. 6 Comparison Between H.264, MPEG-4, and JPEG (picture quality vs. bit rate)

[*4] The graph shows just one example of comparing bit rates at which JPEG, MPEG-4, and H.264 images can be transmitted. Actual bit rates for transmitting data using these three compression formats differ with image quality and image size settings.

Bandwidth and Storage Capacity Calculations

When designing your surveillance system, it is essential to prepare a sufficient amount of storage and network bandwidth. The following is an example showing how to calculate the required network bandwidth and storage capacity to transmit and store JPEG images.

JPEG

Formulas for Calculating Bandwidth and Storage Capacity

$$\text{Bandwidth (Mb/s)} = \left[\frac{\text{Image data size (KB)}}{\text{frame}}\right]\left[\frac{\text{\# frames}}{\text{sec}}\right]\left[\frac{\text{8 bits}}{\text{Byte}}\right]\left[\frac{\text{1 MByte}}{\text{1000 KB}}\right]$$

$$\text{Storage capacity (MB/hour)} = \left[\frac{\text{Image data size (KB)}}{\text{frame}}\right]\left[\frac{\text{\# frames}}{\text{sec}}\right]\left[\frac{\text{3600 sec}}{\text{hour}}\right]\left[\frac{\text{1 MB}}{\text{1000 KB}}\right]$$

$$\text{Storage capacity (GB/day)} = \left[\frac{\text{Storage capacity (MB)}}{\text{hour}}\right]\left[\frac{\text{24 hours}}{\text{day}}\right]\left[\frac{\text{1 GB}}{\text{1000 MB}}\right]$$

Sample Calculation for a Four-Camera Installation*5

	Resolution Compression level	Image data size	fps*6	Bandwidth	Required storage capacity/hour	Required storage capacity/day
Camera1	VGA Level 5	30 KB	30 fps	7.2 Mb/s	3240 MB	77.76 GB
Camera2	QVGA Level 5	7.5 KB	10 fps	0.6 Mb/s	270 MB	6.48 GB
Camera3	QVGA Level 2	4.5 KB	10 fps	0.36 Mb/s	162 MB	3.88 GB
Camera4	QQVGA Level 5	1.875 KB	20 fps	0.3 Mb/s	135 MB	3.24 GB
Totals				8.46 Mb/s	3807 MB/hour	91.36 GB/day

MPEG-4/H.264

Because of the nature of MPEG-4 and H.264, it is very difficult to accurately calculate required network bandwidth and storage capacity as we did with JPEG. As explained above, these compression methods are based on the difference in movement within a scene; therefore, scenes with little movement require less data than scenes with significant movement.

The MPEG-4 and H.264 bandwidth settings in these cameras can be preset to any of the nine levels as follows:
MPEG-4: 64, 128, 256, 384, 512, 768, 1024, 1536, 2048 Kb/s
H.264: 32, 64, 128, 256, 384, 512, 768, 1024, 1536 Kb/s

*5 This table shows sample calculations for reference purposes only. Actual bandwidth and storage requirements should be properly tested with each system installation.
*6 Maximum frame rate might be limited depending on compression level, resolution, and camera function settings. For more details, please contact your local Sony sales office or authorized dealer.

Dual Encoding Capability

The Sony SNC-RX550/RZ50/CS50 Series of network cameras is equipped with a dual encoding capability that generates both MPEG-4 and JPEG images simultaneously. This feature further expands your surveillance and monitoring applications by offering flexible system configurations. For example, it allows live monitoring of clear and smooth MPEG-4 streams over a WAN or an Internet VPN, where network bandwidth is limited, while storing high-resolution JPEG images on removable media inserted into the camera's built-in card slot(s) (Fig. 6). Or, you can record high-quality JPEG images using the IMZ-RS Series software configured with a server on a LAN, while distributing MPEG-4 streams to multiple PCs running the Microsoft® Internet Explorer® browser over a WAN/VPN (Fig. 7).

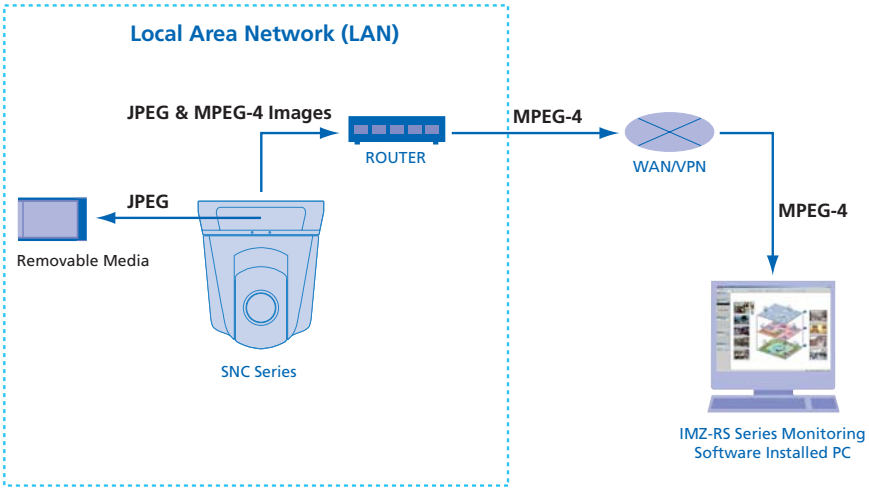

Fig. 6 Dual Encoding (streaming while recording locally on removable media)

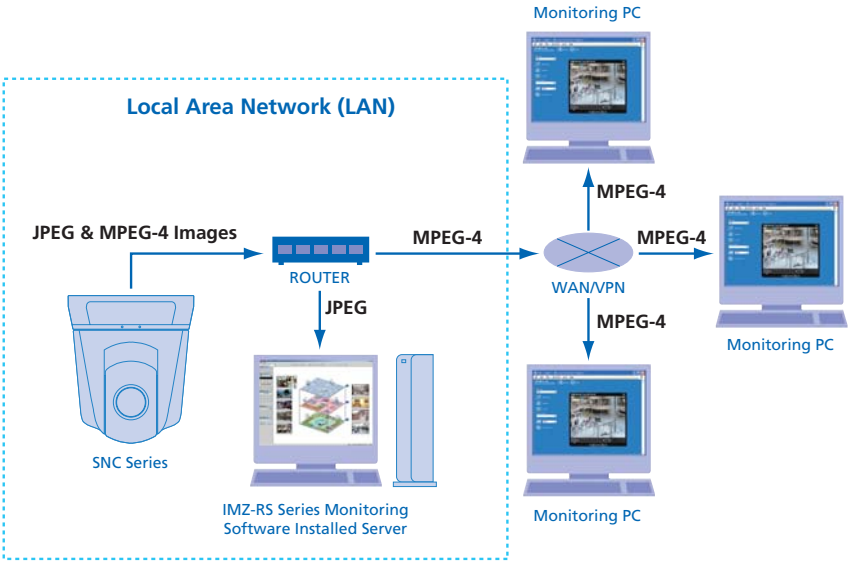

Fig. 7 Dual Encoding (streaming while recording locally on server)

Motion Detection Basics

To understand the "Intelligent Motion Detection" and "Intelligent Object Detection" functions built into the Sony SNC-RX550/RZ50/CS50 Series of network cameras, it is important to first understand motion detection in general.

What is Motion Detection?

Motion detection is a relatively common feature built-into surveillance equipment.

One benefit of motion detection is that it can greatly reduce the required storage capacity of a recorder. A surveillance system can be configured in several different ways depending on what is being monitored. For example, the recorder can be set up to store low-resolution images at a low frame rate or to record nothing at all to save storage capacity under normal conditions. When an alarm is triggered by movement, the recorder automatically begins to record higher-resolution images at higher frame rates so that critical scenes can be clearly captured.

Another benefit of motion detection is that it can alert operators when movement has been detected in several ways, for example by sending an e-mail notification, providing an audible alert with a pre-recorded audio file, flashing an alarm message on the monitor, or by displaying a full-screen image from the camera that detected movement. What's more, the alarm can trigger local image recording or move the camera to a preset pan/tilt/zoom position to get a closer look at the monitoring object. In addition, the system can be configured to perform any of the following actions and more when movement has been detected: sounding an audible alarm, turning lights on/off, triggering a door lock, etc.

Conventional Methods of Movement Detection

A variety of detecting methods have been designed into surveillance equipment from the time these systems were first sold. Sony has incorporated movement detection features not only in recorders but also in cameras.

Sony first-generation network cameras that employ the JPEG compression format, such as the SNC-RZ30/Z20/CS3, incorporate a basic detection method that compares the average change in luminance levels between adjacent frames (i.e. adjacent JPEG images) on a pixel basis. If the result is greater than a preset threshold, then it is treated as motion in the monitoring area, and triggers an alarm (Fig.1).

Another detecting method that was incorporated in Sony second-generation network cameras, such as the SNC-RZ25/DF70/DF40/CS11/CS10, employing the MPEG-4 compression format, utilizes motion compensation inherent in MPEG-4 compression. Motion compensation is based on movement within 16 x 16 pixel areas of an image called "macroblocks." In the motion-compensation process, motion vectors, which are based on the direction, speed, and distance of a moving object within each macroblock, are determined. These motion vectors are then added and if the resultant vector exceeds a preset threshold level, an alarm is triggered (Fig. 2).

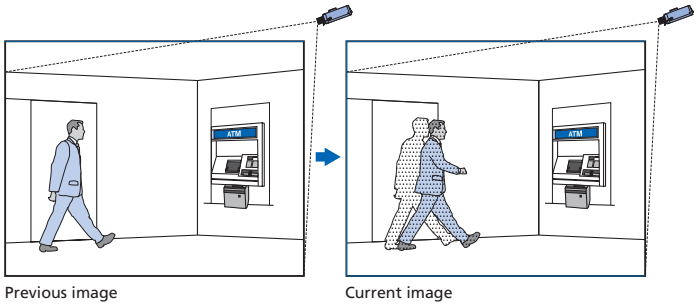

Fig. 1 Detection Using Average Change in Luminance of Pixels

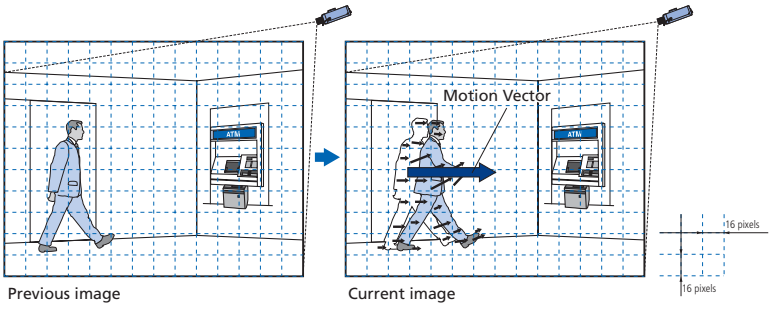

Fig. 2 Detection Using Motion Vector

Intelligent Motion Detection (IMD)*1

The "IMD" function incorporated in the Sony SNC-RX550/RZ50/CS50 Series of network cameras makes further strides in motion-detection functionality. By utilizing a sophisticated and robust movement-detection algorithm, these cameras drastically lower the number of false alarms.

Conventional methods, as described earlier, compare the difference between two adjacent frames; however, "IMD" utilizes 15 frames to determine whether or not to trigger an alarm (Fig. 1). By analyzing more frames and movement patterns, "IMD" can distinguish the difference between the movement of actual objects or persons that are supposed to trigger an alarm and repeated motion patterns such as shaking leaves on a tree and ripples in water that are not supposed to trigger an alarm. As a result, accidental alarm triggers are minimized.

This sophisticated algorithm also minimizes false alarms that can result from camera vibration, and can differentiate between moving objects and shadows, further increasing the accuracy of motion detection. Moreover, the "IMD" function can be used when the camera is operating in MPEG-4, JPEG, and dual-encoding (MPEG-4/JPEG) modes.

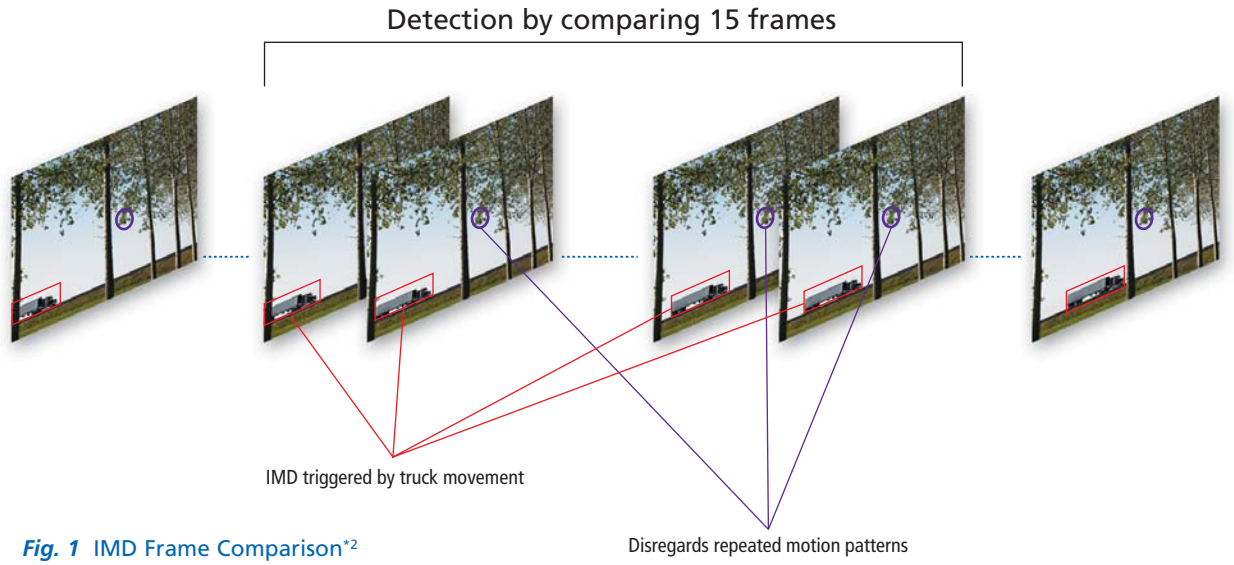

Fig. 1 IMD Frame Comparison*2

*1 The "IMD" function cannot be used when the camera is operating in H.264 mode.

*2 The figure above shows sample images to depict "IMD". The markings on the images do not appear on the monitoring display. They are used for illustration purpose only.

Intelligent Object Detection (IOD)*1

In addition to "Intelligent Motion Detection," the SNC-RX550/RZ50/CS50 Series of network cameras is equipped with an "Intelligent Object Detection" function.*2 With the "IOD" function, these cameras can determine whether or not there are abandoned objects or objects that have been removed from the monitoring area. This feature can prove useful for detecting suspicious objects left in public spaces, illegal parking, stalled cars or accidents on the road, or for detecting articles that have been removed from museums, warehouses, or other places of business.

Whether detecting an abandoned object or an object removed from the monitoring area, the camera's detection methods and algorithms are identical. The IOD algorithm is such that the camera first creates a "base image," and stores it in the camera's memory. This base image can be the entire area being monitored or a pre-specified area in the scene. The image currently being monitored is compared to the base image and areas where a change has occurred are regarded as "potential alert areas." The camera then continues processing subsequent frames. After a period of time the camera determines that an object was either removed or was left behind, and defines an "alert area," triggering an alarm (Fig. 1). In order to accommodate scene environment changes, the base image is regularly updated as time passes.

A briefcase is left unattended.

The camera identifies a "potential alert area."

The camera defines an "alert area."

Fig. 1 IOD Mechanism*3

*1 The "IOD" function cannot be used when the camera is operating in H.264 mode.
*2 "IOD" and "IMD" cannot be used simultaneously.
*3 These are sample images to depict "IOD." The highlighted areas and red rectangle do not appear on the monitoring display.

Spherical Privacy Zone Masking

Privacy concerns have become an important worldwide issue in all aspects of society. Likewise, in surveillance and monitoring applications, privacy protection is not only desired but sometimes mandatory as defined by laws and ordinances.
The Spherical Privacy Zone Masking function incorporated in the SNC-RX550 and SNC-RZ50 Series of network cameras is a sophisticated masking method that responds to these requirements.

Privacy zone masking is a feature in surveillance applications that is used to protect personal privacy by masking private areas in the camera's field of view, such as windows and doorways that are within the monitoring area but not subject to surveillance, and other private property. Many manufacturers incorporate a privacy zone masking function in surveillance recorders and monitoring software, but may not incorporate this function in cameras. However, in networked video surveillance applications, privacy zone masking on the recorder or processing device poses a major security concern, because images captured by a camera are streamed over a network before the mask is generated. What's more, delays can occur when processing masking data on recorders or with software because the mask is generated after streamed image data is received.
To mitigate the risks associated with this type of processing, the Sony SNC-RX550 and SNC-RZ50 Series of network cameras incorporate the Privacy Zone Masking function in the camera itself.

With these network cameras, the masked areas of the image are dynamically interlocked with the camera's Pan/Tilt/Zoom (PTZ) movements for comprehensive image masking (Fig. 1) – this is called "Spherical Privacy Zone Masking." The spherical masking mechanism works as follows: when you specify the area and color of a mask, the camera produces a signal to generate an image that replaces the data for that area with a mask. This data, along with the camera's PTZ settings are stored in the camera's memory. When the camera pans, tilts, and/or zooms, the PTZ settings are updated, and the mask is repositioned so that it continues to cover the original masked area. This data is updated every 50 ms so that regardless of the PTZ speeds, masked areas within the image remain covered. A maximum of eight masking areas and one of nine masking colors can be set for each camera.

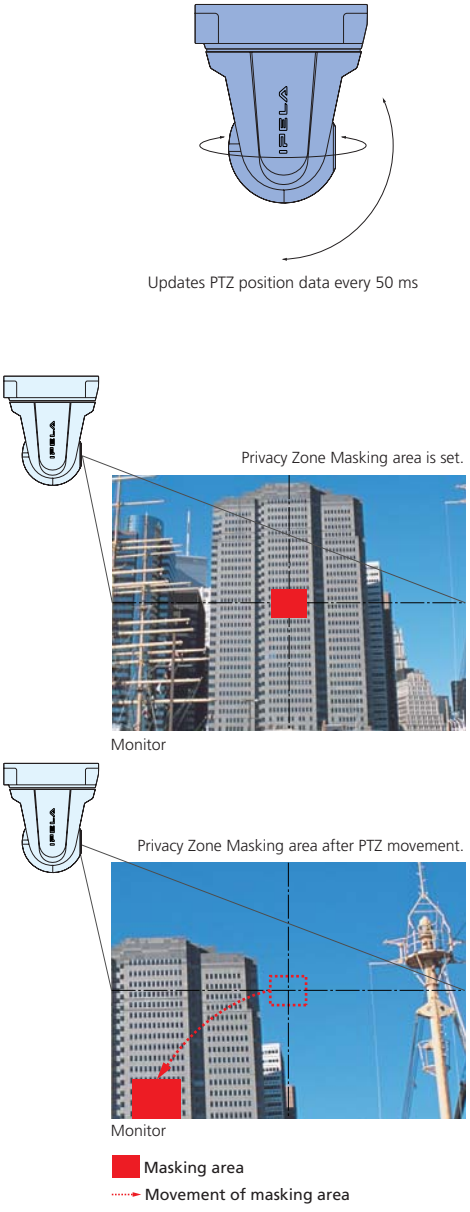
Updates PTZ position data every 50 ms
Privacy Zone Masking area is set.
Monitor
Privacy Zone Masking area after PTZ movement.
Monitor
Masking area
Movement of masking area

Fig. 1 Spherical Privacy Zone Masking

Image Stabilizer

In outdoor surveillance and monitoring applications, surveillance cameras are usually attached to poles or mounted on buildings. Depending on the installation site, captured video might be displayed as shaky images resulting from vibration caused by wind and other environmental effects. The image stabilizer function incorporated in the Sony SNC-RX550/RZ50/CS50 Series of network cameras minimizes the effect caused by high- and low-frequency vibration to provide stable images. This function is especially useful for outdoor surveillance and traffic-monitoring applications.

The image stabilizer mechanism works as follows: when the image stabilizer function is activated, the camera assigns a 5% border area in the image to compensate for camera vibration (Fig. 1).[*1] An 8 x 8 matrix of calculation blocks (reference areas in the image) are assigned as calculation points for motion vectors (Fig. 2). The camera stores 30 frames of this image data in its memory. Movement of each calculation block is compared frame by frame using what is called a Block Matching Algorithm (BMA),[*2] and individual motion vectors are calculated (Fig. 3). The system is such that individual motion vectors associated with movement of objects or beings within the image are disregarded. Individual motion vectors associated with movement of the camera are then processed to obtain an average resultant motion vector for the entire image (Fig. 4). The camera then shifts the image to the direction opposite that of the resultant motion vector to correct for any camera movement (Fig. 5). Because the camera stores data from the past 30 frames, these motion vectors are continually updated and corrected in such a manner that the resultant image is smooth and natural (i.e. the correction process is performed incrementally so as not to cause abrupt transitions in the image).

The image stabilizer function is effective in environments where the vibration frequency of the camera is approximately 2 Hz. This function can be used when the camera is operating in MPEG-4, JPEG, and dual-encoding (MPEG-4/JPEG) modes as well as when "Intelligent Motion Detection" or "Intelligent Object Detection" are active.

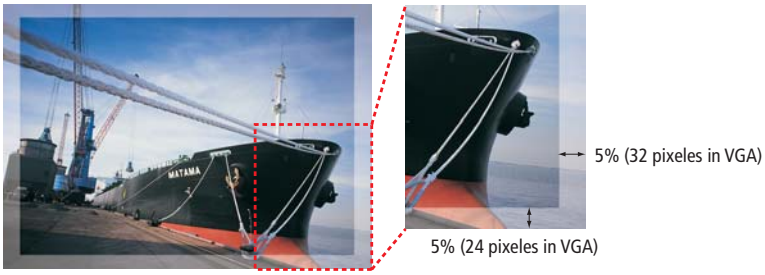

Fig. 1 Border Area (5% of image)

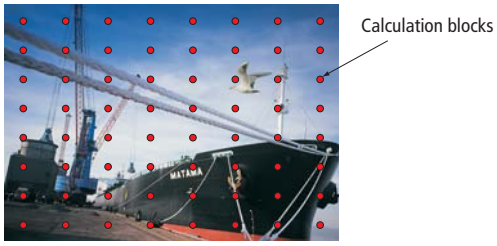

Fig. 2 Calculation Blocks (8 x 8 matrix)

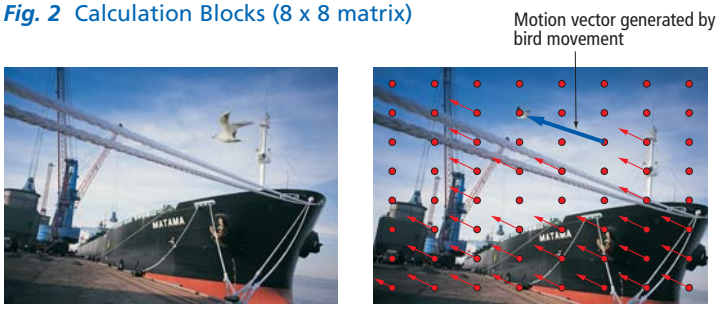

Fig. 3 Individual Motion Vectors

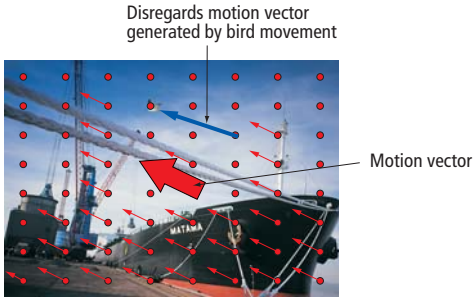

Fig. 4 Resultant Motion Vector for Camera Movement

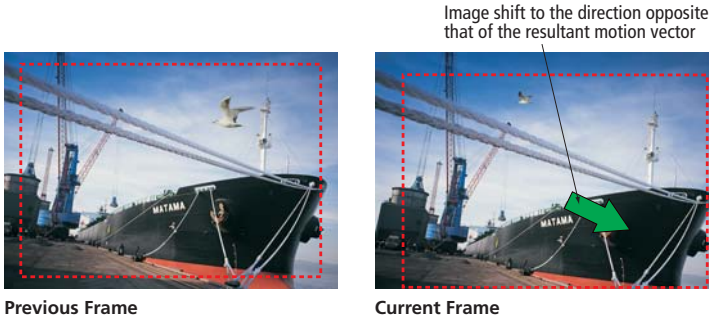

Fig. 5 Image Shift to Compensate for Camera Movement

[*1] Digital zoom is used to allow for compensation; therefore, the effective viewing area is reduced. Depending on the settings, the camera might operate at a lower frame rate due to the amount of processing required by the camera.

[*2] BMA is an algorithm for locating matching blocks in a sequence of video frames for the purposes of motion compensation.

Dynamic Frame Integration (DFI)

The Sony SNC-RX550/RZ50/CS50 Series of network cameras incorporates "Dynamic Frame Integration" technology to reproduce clear and smooth images for both still and moving areas within an image. This technology takes advantage of the relatively high sensitivity inherent in interlaced scanning CCDs, which are incorporated in these cameras.

A technology called I/P (Interlace/Progressive) conversion is required to produce progressive pictures from a camera that employs interlaced scanning CCDs.
One method of producing these progressive pictures is to simply combine two adjacent picture fields into one picture frame. This is called "Frame Mode" in Sony network cameras. This method provides high vertical resolution and works well for still areas within an image; however, if a fast-moving object appears in the image, those areas with movement become blurry (Fig. 1-A).
On the contrary, "Field Mode," which is an optional setting with these network cameras, produces progressive pictures by utilizing data from the even field only (i.e. lines 0, 2, 4, 6...). This method reproduces absent lines of the interlaced field by interpolating data from the lines above and below them. "Field Mode" can reduce blurred images caused by fast-moving objects; however, vertical resolution is half that of "Frame Mode" and this method of processing images can produce jagged edges in still areas of the image, particularly in angled lines with high contrast (Fig. 1-B).

Combining the advantages of the two I/P conversion techniques, DFI technology adaptively selects from "Frame Mode" and "Field Mode" within an image to reproduce a progressive picture. The algorithm is such that it detects 'Motion' within an image on a two-pixel basis. For areas where motion is detected, DFI applies "Field Mode" to minimize blurring, and at the same time, it applies "Frame Mode" to still areas to maintain high resolution without jagged edges (Fig. 1-C).[*1] In summary, DFI technology takes advantage of the high sensitivity inherent in the SNC-RX550/RZ50/CS50 Series of cameras to produce clear and smooth images even under low-light conditions (Fig. 2).

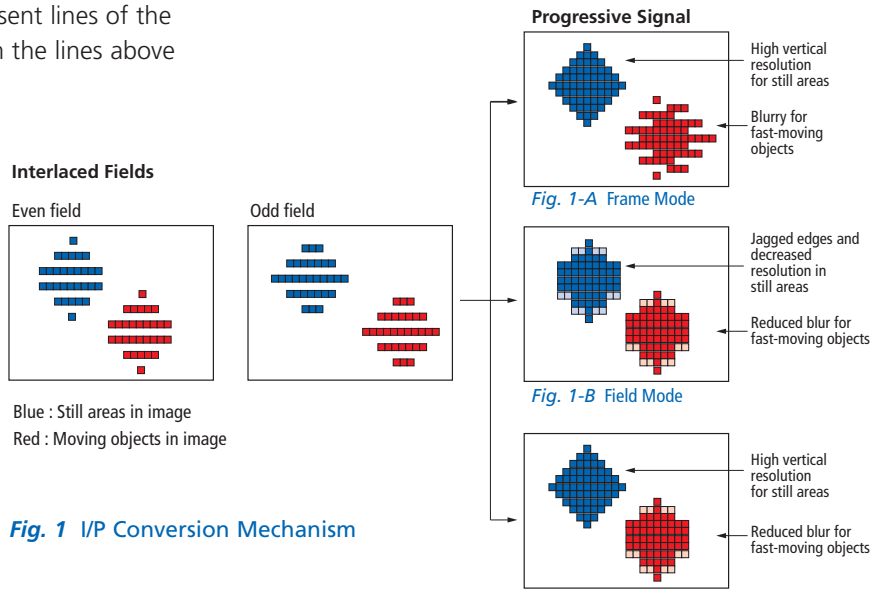
Progressive Signal
High vertical resolution for still areas
Blurry for fast-moving objects
Fig. 1-A Frame Mode
Interlaced Fields
Even field
Odd field
Jagged edges and decreased resolution in still areas
Reduced blur for fast-moving objects
Fig. 1-B Field Mode
Blue : Still areas in image
Red : Moving objects in image
High vertical resolution for still areas
Reduced blur for fast-moving objects
Fig. 1-C Auto Mode (DFI ON)

Fig. 1 I/P Conversion Mechanism

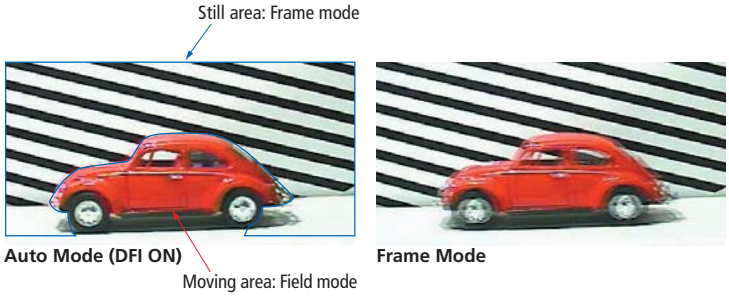

Fig. 2 Comparison Between Auto Mode (DFI ON) and Frame Mode

[*1] Depending on the scene, the DFI algorithm may not process the image properly; however, the image will always be clearer than that of Frame Mode.

CCDs (Super HAD CCD/Exwave HAD/SuperExwave Technology)

As a leading manufacturer of image sensor products, Sony has developed a wide variety of CCDs for a number of decades, and these CCDs have been used worldwide in a great number of camera products. Sony CCDs utilize a common HAD structure that reproduces images with reduced smear and low noise characteristics. In addition to the benefits of the HAD structure, refinements in the On-Chip Lens (OCL) layer and CCD's photo sensors have significantly contributed to improved CCD picture performance.

The SNC-RZ50, SNC-RX550, and SNC-CS50 Series of network cameras incorporate a Super HAD CCD, CCD with Exwave HAD technology, and CCD with SuperExwave technology, respectively. These CCDs have been incorporated into each camera making them ideal for applications ranging from surveillance to web attractions. In the following sections, we will take a detailed look at the different CCD types.

Super HAD CCD

When compared to the first generation of On-Chip Lenses developed in 1989, the Super HAD CCD has an improved OCL layer providing much greater sensitivity. As shown in Fig. 1, the first-generation On-Chip Lenses above each pixel are separated by gaps, and the light that falls on these gaps is wasted. Whereas, the Super HAD CCD OCL structure is virtually gapless (Fig. 2), which raises its light-convergence capability and provides a drastic improvement in sensitivity.

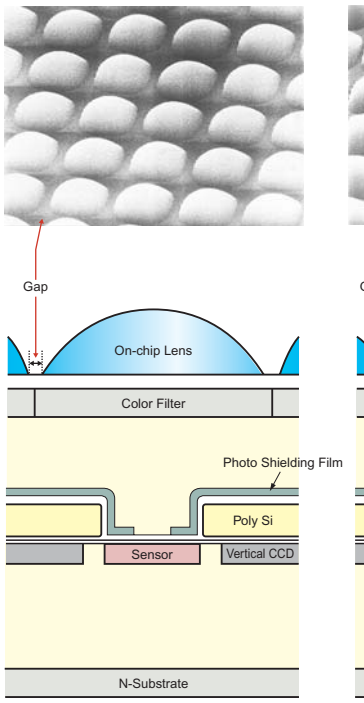

Fig. 1 First-generation On-chip Lens

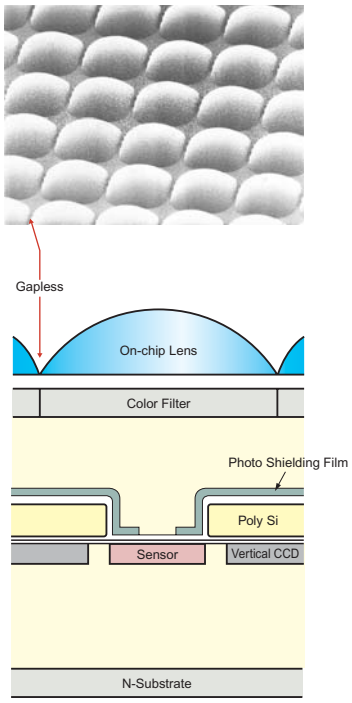

Fig. 2 Super HAD CCD

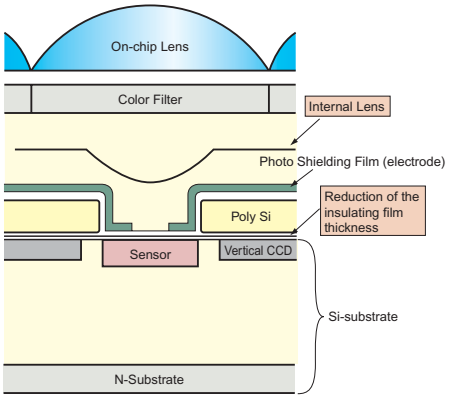

Fig. 3 CCD with Exwave HAD Technology

CCD with Exwave HAD Technology

The CCD with Exwave HAD technology was developed to provide extra sensitivity for both visible and near infrared regions of the spectrum, allowing the camera to capture bright images both during the day and night.

Inheriting the OCL structure from the Super HAD CCD, Exwave HAD technology further increases sensitivity by incorporating an internal lens layer between the color filter and photo shielding film (Fig. 3). These internal lenses are used to efficiently converge light that was not converged toward the photo sensor by the OCL. This double convergence structure enables more light to be directed to the photo sensors.
As a result, the CCD incorporating Exwave HAD technology has a higher sensitivity than the Super HAD CCD.

In addition to this higher light convergence capability, Exwave HAD technology uses a unique structure to improve the CCD sensitivity to near infrared light.
This enhancement allows much brighter images to be captured in the dark using the Day/Night function.
With earlier CCD structures, near infrared light was difficult to capture because of its nature of being converted to electric charges in areas deeper than the photo sensor surface. By extending the photo sensor deeper into the silicon substrate, the CCD with Exwave HAD technology achieves a much higher sensitivity to infrared light, allowing images to be captured in extreme darkness.
Furthermore, Exwave HAD technology incorporates a thinner insulating film between the silicon substrate and the electrodes. Compared to earlier-generation CCDs, this structure reduces the amount of light that leaks directly into the vertical shift register, and suppresses the smear level.

CCD with SuperExwave Technology

SuperExwave technology adds a further improvement to the sensitivity of Exwave HAD technology, especially for near infrared light. SuperExwave technology improves on Exwave HAD technology by changing the structure of the photodiodes in such a manner that it has even higher photoelectric conversion efficiency. This structure can capture even more of the light in the near infrared region that would normally escape to the substrate in normal CCD image sensors. As a result, the sensitivity in the near infrared region is increased by approximately 50%, and sensitivity of visible light is increased by approximately 10% compared to the CCD with Exwave HAD technology (Fig. 4).

<SuperExwave> <Exwave HAD>

Shooting environment: LED lights (wavelength 950 nm, irradiation distance 1 m), Dark room

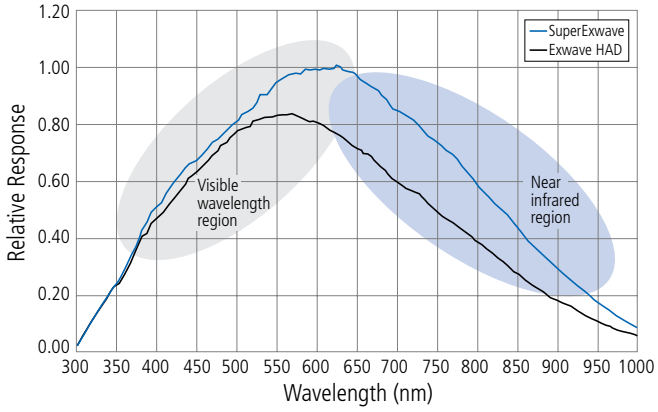

Fig. 4 Comparison Between SuperExwave and Exwave HAD Technology*1

*1 This chart has been simplified to show the difference in sensitivity between SuperExwave and Exwave HAD. The values are for reference only.

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